TEXTILE RESEARCH

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TEXTILE RESEARCH

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VOL. XIII **TEXTILE RESEARCH** NO. 3

Outstanding Features in

This Month's Issue

Research Manpower in High Schools

A. G. Ashcroft reports an original plan in operation at the Alexander Smith & Sons Carpet Co. for increasing the supply of research technicians by means of practical training of high school seniors. (See page 2.)

Properties of Bubblfil

An outline of the properties of Bubblfil and comparison with those of other buoyant materials is given by A. G. Quig. (See page 8.)

Controlled Molecular Length

Research Associates of the Textile Foundation report tests of acetate films prepared from fractions of cellulose acetate of different molecular chain lengths. (See page 17.)

Abstracts

In this issue is inaugurated a new department that will include abstracts of important articles appearing in technical and scientific publications. (See page 32.)

Practical Plan Is Presented For Tapping Reserves of

Research Manpower in High Schools

By A. GRIFFIN ASHCROFT*

IN THE INDUSTRIAL RESEARCH LABORATORIES in the United States there were, in 1929, about 20,000 engineers and chemists. It is estimated that the number is over 80,000 today—a fourfold expansion in a little more than a decade. In addition to this basic growth, war requirements have increased the demands on industrial research. These demands, together with loss of personnel to the Armed Forces and Specialists Branches, have created a situation in which most industrial laboratories are facing a serious manpower shortage, a shortage which is most evident in the technical assistants group, and in the groups which would enter industry from college. Although many laboratories have employed female chemists, there is no available quantity of this desirable substitute.

It occurred to us at Alexander Smith's in searching for some solution which would offer hope for the future, that we had no regular technique for tapping the reservoir of students from the local high schools who normally each year graduated as engineers and chemists from universities and colleges all over the country. In general, these students having no contact with their local industries have gravitated to research groups in other cities.

We obtained the immediate cooperation of the vocational guidance directors of our local high schools, and began a systematic survey with them of the senior high school students with the highest marks in various science

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and mathematics courses. As the result of a study of I.Q. ratings, the classification of teachers and interviews, and finally the Stanford University scientific aptitude test, and a vocabulary test, a group of ten senior high school students were chosen. The school authorities arranged their courses so that they could be completed during the morning hours, and it was arranged that they should work in our laboratories from 2 to 5 P.M. and Saturday mornings, thus putting in half of a normal work week or 20 hours.

The seven boys and three girls who were employed were assigned by aptitude selection to either quality control work or as assistants on development problems. The quality control testing to which they were assigned was, for example, sampling, weighing, strength testing, fire resistance, and porosity testing of duck and tarpaulin; weight, strength, color fastness of blankets; weight, strength and twist of purchased yarns and woolen yarns from our own mill; control testing of scouring, dyeing, sizing and other similar textile mill quality control work. In the field of research and development certain of the boys with especially high research aptitudes were assigned as assistants to our research chemists and engineers. Their work included testing of experimental coatings, laying out of yarn and product trials; keeping of reports and records of research tests and service assistance of a general nature to the supervisory experimental workers. It is especially worthy of emphasis that these students required a surprisingly short time for job training and in a few weeks were performing successfully the tasks assigned to them.

They are interested in helping in the war work that we are doing and at the same time in being able to complete their high school education. The rate at which they are being paid is somewhat higher than the average rate for their age group in our locality. They are interested in the vocational guidance aspects of pre-professional contact with industry. They are at the point where their

Maitland L. Griggs, vice pres. Alexander Smith & Sons Carpet Co., pinning a company identification button on the work smock of a girl in the first group of senior high school students employed by the company in its experiment with the use of high school manpower reserves.

first choice of their own destiny must be made. Their interest is therefore stimulated by their desire to know more about the fields into which their choice of a career might lead them. Furthermore, the ten high school students employed are replacing successfully some young men of draft age formerly used in similar work.

Psychologically these youths are a fertile field for vocational guidance in the scientific fields. The fact that they are the top of their class in science and mathematics suggests them as an excellent source of our future chemists and engineers, and they may have certain qualities which, in particular would fit them for work in industrial research. It is an unfortunate fact that our universities have not as yet organized to bring to the front those in the technical groups having special aptitudes for research. Work in an industrial laboratory

before entering college permits the high school senior to visualize himself in this field and allows the research director to watch for special research qualities that deserve encouragement and vocational guidance.

In starting contrast to the somewhat complacent and cynical attitudes of older personnel is the spirit of enthusiasm and the spark shown by these youths.

The future values from this manpower replacement effort appear to us to be manifold. This particular group of ten students and the new recruits we plan to employ each year, will furnish a technical group from the universities for summer and vacation substitution work. Many of the boys no doubt will go into the armed services next June but if we find them particularly desirable for future employment, we will encourage the maintenance of a bond of some sort with us that will lead to their continuing their future education in engineering when this becomes possible. During the period that they are in our employ we can influence their future training and while they are in college guide them toward special fields in which we have a particular interest. We will also know certain of these graduates by experience with them in our own work and this assurance would make their employment more of an investment than a gamble.

We are reporting on this rather new use of manpower reserves in the hope that our results with it will encourage the textile industry to an extension of our pioneering in this direction. It may be that this presages a significant change not only in the development of research workers but in the educational methods used in the training of scientists and professional men throughout industry. It may be that this would put in practical form the advisory nature of the present status of vocational guidance in our high schools. Such a contribution would have tremendous significance because in the high school senior group are the future textile research chemists, physicists and engineers in whose hands may rest the future of the textile industry.

RESEARCH ACTIVITIES

The organization of textile research for war was the subject of an address by F. S. Blanchard, president of the Textile Research Institute, before the Textile Section of the American Society of Mechanical Engineers held in connection with the recent annual meeting of the Society in New York. Mr. Blanchard described the research organization of the textile industry and outlined some of the war problems on which the Textile Research Institute and the Textile Foundation are actively engaged.

Professor W. E. Shinn of North Carolina State College and research consultant on the work being conducted at that institution in connection with the co-operative warp sizing research project of the Textile Research Institute, is now in active service as Major in the Army.

Possibilities for the combination of research with higher education on the graduate level, is being actively studied by the Textile Research Institute and Textile Foundation. Recently a visit was made to the Institute of Paper Chemistry at Appleton, Wisconsin, the Institute of Gas Technology and the Armour Research Foundation at Chicago, and the Mellon Institute at Pittsburgh. Besides studying the development and organization of research work in these institutions, particular attention was given to the policies under which research and higher education are successfully combined at the first two of the above institutions. F. S. Blanchard, president of the Textile Research Institute, Fuller E. Callaway, president of Callaway Mills, Earl Heard, dean of the Philadelphia Textile Institute, and Edward T. Pickard of the Textile Foundation—all

directors of T. R. I.—made the visit and came back much impressed with what they had seen and the progress made. As Mr. Blanchard pointed out in a talk recently given before the Textile Division of the American Society of Mechanical Engineers, we shall find the paper industry after the war far advanced in the organization of research and in the development of paper products for important uses now enjoyed by textile materials.

R. F. Nickerson who for the past five and one half years has been Senior Industrial Fellow at the Mellon Institute in Pittsburgh, assigned to work sponsored by the Cotton Research Foundation of Memphis, Tennessee, is now with the Nekoosa-Edwards Paper Co., Port Edwards, Wisconsin. His new position involves research and development on specialty papers which will have immediate and useful application in the war program.

Winfield B. Heinz of the Calco Chemical Division, American Cyanamid Co., recently left that organization in order to establish a consulting business of his own. Mr. Heinz is vice chairman of the textile division of the American Society of Mechanical Engineers and a member of the Textile Research Institute War Council. He is engaging in the engineering development of new products, new manufacturing equipment, and modernizing improvements to existing equipment, with office on Middlebrook Road, Bound Brook, N. J.

Erb N. Ditton, technician of the Gotham Silk Hosiery Co., and a director of American Association of Textile Technologists as well as a director of Textile Research Inst., is now in active service with the Army.

Buoyancy, Lightness, Warmth, Are Outstanding

Properties of Bubblfil

By JOSEPH B. QUIG*

Although the idea of entrapping air in viscose fibers, is not new, as evidenced by a patent issued to J. E. Brandenberger in 1921, the development of a practical process for producing a usable material is new. The following article which is condensed from a paper delivered at the meeting of the American Association of Textile Technologists held in New York, December 9, describes some of the important uses to which Bubblfil is adapted and compares the qualities of the new product with those of kapok, a critical war material.

THE RESEARCH which resulted in Bubblfil was undertaken in order to develop a material which would have properties similar to prime java kapok, supply of which has principally been exported from Java and the Phillippines. An inferior grade of kapok has a wider distribution in Asia, Africa, both Americas and Australia but prime java kapok has been the only satisfactory fiber for use in life saving equipment. Although Bubblfil is new and neither its physical form nor its final performance is fully established, the possibility of replacing materials critical in the war effort has dictated offering this product at the present time. It is also conservative to envisage that the Bubblfil system of spinning may produce textile yarns of new textural interest after the war.

* Assistant director Development Section, Rayon Department, E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

With similar properties to such products as viscose rayon, cellophane, and cellulose sponge, with respect to aging, temperature, resistance to moisture, mildew, etc., Bubblfil, chiefly by virtue of its cellular structure (see Fig. 1) and entrapped air, offers certain characteristics not commonly associated with these products. These properties may be summarized:

(1) A unusually low ratio of weight to bulk.

(2) Flotation properties of a high order.

(3) A Significant capacity for providing heat insulation.

(4) Unique characteristics with respect to compressibility and resilience.

Since kapok has limited possibilities as a textile fiber, many of us know very little about it. The outstanding properties of kapok are its lightness, resiliency, resistance to water, buoyancy, and its capacity thermal and sound insulation. The fiber is smooth-walled and straight which prevents it from matting and so con-

Fig. 1. Slightly enlarged photograph of several strands of "Bubblfil" showing air-filled bubbles of cellophane.

tributes to its remarkable resiliency. Compressed to two feet in hydraulic presses and held in this position for a considerable time, the floss rises in a few minutes, after being opened, to a height of five feet or more.

The high non-conductivity of kapok is due to its hollow structure (see Fig. 2), which also contributes in large measure to its buoyancy, each fiber consisting of a single air filled cell, closed at both ends.

However, kapok is inflammable, and the structure of these fibers breaks down too easily, resulting in a consequent loss in buoyancy and insulating properties.

In comparing the properties of Bubblfil with those of other buoyant materials, particularly with kapok, it is important to distinguish whether the buoyancy is expressed in terms of the weight or of its volume. In other words, since various weights of Bubblfil can be put into any given volume, the buoyancy of one cubic foot will vary in accordance with the weight packed in that cubic foot.

The density of medium Bubblfil is 0.043 gm./cc. as compared with 0.311 gm./cc. for Java kapok (see Table I). However, the very low density of individual strands is partially offset by the fact that the bubbles do not compact easily into a small space, and although it has, when packed loosely, a buoyancy per given weight which closely approximates kapok,

Fig. 2. Cross section of kapok fibers, showing hollow structure. Mag. × 500.

it requires 1.7 times as much medium Bubblfil to equal the buoyancy of kapok in terms of the volumes (lbs. per cu. ft.) of buoyant material used (see Fig. 3).

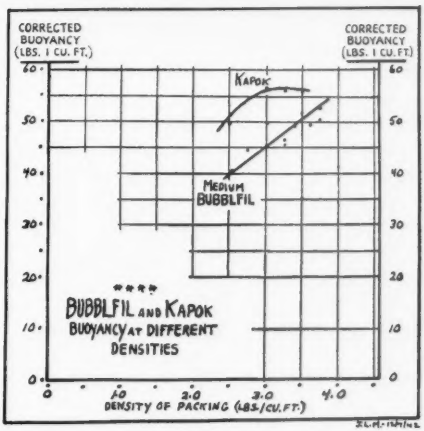
CORRECTED BUOYANCY (LBS. I CU. FT.)
CORRECTED BUOYANCY (LBS. I CU. FT.)
KAPOK
MEDIUM BUBBLFIL
BUBBLFIL AND KAPOK BUOYANCY AT DIFFERENT DENSITIES
DENSITY OF PACKING (LBS./CU.FT.)

Fig. 3.

During periods of immersion in salt water at various temperatures Bubblfil retains its buoyancy considerably better than does kapok (see Fig. 4). The buoyancy of the latter takes a notably sharp drop during the first three days.

The military authorities have tested and approved Bubblfil in certain applications such as the following:

EMERGENCY BUOYANT FILLER FOR LIFE BOATS AND LIFE RAFTS.—These are kept afloat by air tanks, which in the early days of the war were filled with kapok to provide emergency buoyancy in case of puncturing by bullet or shell and Bubblfil has been tested and approved for use by the Coast Guard.

(Continued on page 12.)

TABLE I. Bubblfil properties compared with other buoyant materials.

Item	Denier	Bubbles per Meter	Density (In Benzene) gm/cc	Density (In Benzene) lb./cu. ft.
Medium BUBBLFIL	1450	115	0.043	2.71
Large BUBBLFIL	3260	65	0.038	2.38
" "	4050	11.66	0.035	2.16
" "	2385	11.96	0.023	1.43
" "	2940	3.72	0.023	1.43
Kapok			0.311	19.4
Cork			0.25	16.0
Balsa Wood			0.12–0.20	7.5–12.5

LIFE JACKETS.—It has been found that Bubblfil may be used satisfactorily in standard Navy life jackets.

The excellent heat insulation properties provided it is backed by a wind-proof fabric, provide some very important applications. For example, two layers of a very loose Bubblfil fabric, a total thickness of less than one-quarter inch, backed by a layer of aluminium foil, have been shown to be the equivalent of a three-quarter inch pile sheep shearling. Furthermore, it has been shown to be approximately equivalent to down in thermal insulating qualities, and, since it resists compression, retaining the necessary thickness for insulation, it is, in that respect, superior to down for sleeping bags since the latter is not satisfactory at very low temperatures because of its compression under the body. However, Bubblfil is more bulky when rolled up and experiments are being carried on that should effect a compromise between bulk and efficiency of insulation.

AVIATORS' JACKETS.—These are now lined with the bulky sheep shearling, and the weight factor and other drawbacks to garments containing electrical resistance coils make Bubblfil a possible material for the purpose and tests are now underway.

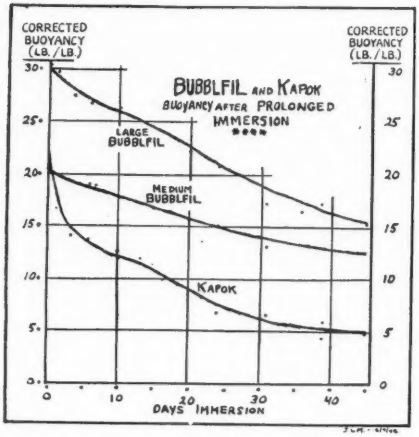

Fig. 4.

While the experimental work is not finished, great strides have been made in the development of a material which may make a definite contribution to the War effort, especially in the replacement of critical materials which cannot be used in flotation equipment.

RESEARCH BRIEFS

Rayon Blends

RAYON BLENDS ON WORSTED SYSTEM. Robert A. Smith. *Textile World,* Sept. 1942, p. 106–109, Oct., p. 90–91; and Nov., p. 78–81.

These three articles by the head of the worsted division, sales service department of American Viscose Corp., present, in detail, specifications for proper preparation of wool and rayon blends, and for machine settings and operation. The data are based on practice worked out at the Textile Unit at Marcus Hook, and will serve as a basis for adaptation to local equipment and development of individual practice. Rayon and rayon blend yarns can be produced on the machinery found in practically all worsted yarn mills.

Cotton Hosiery Portfolio of Design

PORTFOLIO OF DESIGN. David H. Young. *Bureau of Home Economics, U. S. Department of Agriculture,* Washington, D. C. Mailed upon request to trade representatives.

The portfolio, containing 145 full-fashioned designs of women's cotton hosiery compiled for the use of hosiery manufacturers, prepared by David H. Young, senior technologist in the textile and clothing division of the Bureau of Home Economics, is made up of 38 plates, each presenting several of the designs originated by Mr. Young. Information given for each design includes: a photographic illustration of the fabric, 1½ times actual size; a design sketch for laying out movement of the picot bar; and transfer point layout of the picot bar.

Designs covered in the portfolio were knit from combed, gassed, and mercerized yarns on 42 and 45 gauge machines from yarns ranging in count from 90/2 to

140/2. Other effects may be obtained by modifying these specifications, using other machine gauges, or substituting yarns of other numbers.

Although designs contained in the portfolio are of the type designated as novelties, each can be modified for manufacture on installed equipment of 39, 42, or 45 gauge machinery, or in accordance with style requirements.

Measuring Speeds with Stroboscopic Light

Intelligent Use of Strobotac. Raymond W. Mitchem. *Textile World,* Oct. 1942, 92, p. 80–83.

The Strobotac (stroboscopic tachometer), an instrument capable of measuring the speed of any rotating object between 600 and 14,400 R.P.M., is used to determine the speeds of spindles. The instrument is portable, compact, and no mechanical contact with the spindle or spinning frame is required, nor is any power drawn from the latter. Data on tests of 100 spinning frames are given and the ability of the Strobotac to detect operational faults of the frames or of the individual spindles is demonstrated. The author estimates use of the Strobotac will permit increases in spinning room production of 3.5% and increases in quality with no increase in cost per lb.

Latest Developments in Milkweed Floss. Lloyd Stouffer. *Rayon Textile Monthly,* Oct. 1942, 23, p. 55 (603–604).

Milkweed, a native American plant with fibers similar to kapok, has a buoyancy 6 times that of cork, is warmer than wool and 6 times lighter. The stalk yields 3 different fibers, the uses of which are described. 20% of oil can be extracted from the seeds and used in paints and varnishes. Plans for further development of this fiber are outlined.

RESEARCH AIDS

New Frontiers of Research

MANY who have been disappointed in some of the attempts to describe the progress of science in language of the layman will discover in "Science Remakes Our World," * a wealth of information.

The author, James Stokely, received an education in science and was for some years a staff writer for *Science News Service*. He was, recently, director of the Buhl Planetarium and Institute of Popular Science at Pittsburgh, and is now in charge of press relations for the General Electric Company's research laboratory.

Related in concise, but non-technical language, are the underlying principles of outstanding developments in science and research. Of timely interest are the chapters dealing with developments in modern physics, describing the discovery of the electron, the quantum theory of light transmission, and control of the electron stream, and describing the development of the photo-electric cell, the radio, the electron-microscope, and the cyclotron.

For the laymen, this book should eliminate many misconceptions derived from piecemeal stories, and the technical reader will find a conspicuous absence of the marvels and the magic characteristic of many popular writings. It should be a "must" book for one's library.

* SCIENCE REMAKES OUR WORLD. James Stokely, *Ives Washburn, Inc., 29 West 57th St., New York, N. Y. $3.50.*

Locating Laboratory Equipment

ASSISTANCE TO RESEARCH ORGANIZATIONS doing essential war work, in locating needed instruments, is the purpose of a service established by the Committee on Location of New and Rare Instruments under the Division of Chemistry and Chemical Technology of the National Research Council.

This service has already been of valuable aid in

numerous instances. For example, it has been found that supply houses frequently have several items of equipment on their shelves that they do not include in their catalogues. Another example of the practical working out of the service is the recent case of a large industrial concern which required some testing equipment for a special purpose. The needed equipment was discovered at a not far distant university whose intermittent operation of the same made it possible to arrange for its use by the company mentioned.

This service should be of particular value at this time owing to the shortage of many types of special instruments and unobtainable from usual sources.

Inquiries should be sent to, D. H. Killeffer, 60 East 42nd St., New York, N. Y.

Mercerizing*

OF SPECIAL VALUE to research workers and technicians concerned with the production of new and crease resistant finishes for cotton, is a study, from a chemical and physico-chemical basis, of the treatment of cellulose by mercerization by the author of "An Introduction to the Chemistry of Cellulose."

Attention is almost entirely focussed on the treatment of cotton with caustic soda, with some space devoted to linen and rayon. A few chapters are devoted to machinery and machine processing, but, for the most part the book gives a detailed study of the chemical and physical effects. Detailed studies are given with tables and graphical representations illustrating the effects of chemical treatments on fiber, and on yarn, both free and under tension. Dimensional changes, chemical modification of cellulose, swelling and absorption of water, dyestuff, alkali, and iodine, are studied in detail. Crystalline structures with models of molecular structure are illustrated.

* MERCERIZING. *D. Van Nostrand Co., Inc., New York. 458 pp. Price $9.00.*

Improvement in Mechanical Properties Of Cellulose Acetate by Means of

Controlled Molecular Length*

By ARNOLD M. SOOKNE AND MILTON HARRIS**

The mechanical properties of films prepared from a series of fractions of cellulose acetate, varying widely in molecular chain length (DP) [2] *were determined. A fraction of DP 30 would not form a coherent film; fractions of higher DP showed a rapid improvement of mechanical properties with increase in DP, but above 150, further improvement was slight. A close correlation was found between the results of folding endurance and ultimate elongation measurements. These properties are more sensitive than tensile strength to changes in DP and to heterogeneity with respect to DP. Investigation of the properties as a function of both weight-average and number-average DP indicated that at any given weight-average DP, the fractions are superior to the blends and furthermore, those blends which contain fractions of low DP are inferior to those which do not. In contrast, at any given number-average DP within the range studied, the properties of the fractions and all of the blends are approximately equal.*

The mechanical properties of a cellulosic material are influenced by both the average molecular chain length (DP) [2] and the distribution of chain lengths of the mole-

* Full Title of Paper—"Mechanical Properties of Cellulose Acetate as Related to Molecular Chain Length."

** Research Associates of the Textile Foundation at National Bureau of Standards.

[2] By DP (degree of polymerization) is meant the average number of glucose residues per chain. For linear polymers, such as cellulose and its deriva-

cules of which it is composed. There is general agreement, at least for such linear high polymers, concerning relationship between the DP and some of the mechanical properties of a series of relatively homogeneous fractions. It has been shown that below a certain DP, characteristic for each material, no useful filaments or films can be formed. At slightly higher DP's, there is a rapid improvement in the mechanical properties with increase of chain length, whereas at very high DP's, these properties are nearly independent of chain length [2, 3, 4].

No such agreement exists, however, concerning the relationship of chain length to mechanical properties when the materials are very heterogeneous. Several investigators have reported that a blended material gives films or filaments with mechanical properties superior to those prepared from a fraction of the same average DP_w's [5, 6, 7, 8]; others have found the blended materials to be inferior [3, 4, 7, 9] or approximately equal in properties (10). Some of their results are summarized in Table I, which compares the properties of fractions and blends at corresponding DP_w's. In interpreting this table, it should be remembered that the results for films are not necessarily directly comparable with those for filaments, since the degree of orientation is probably considerably greater for the latter in most cases. In addition, the sensitivity of various mechanical properties to changes in homogeneity varies considerably. Unfortunately, most of the investigators have studied only the tensile strength, a property which has been shown to be relatively insensitive to changes in

tives, DP is a measure of chain length. DP will henceforth be designated as either DP_n, (number-average DP) or DP_w (weight-average DP). These are more specifically defined as follows:

$$DP_n = \frac{\Sigma n_i DP_i}{\Sigma n_i}, \quad \text{and} \quad DP_w = \frac{\Sigma w_i DP_i}{\Sigma w_i}$$

where n_i is the number of molecules of DP, DP_i and w_i is the total weight of that molecular species [1].[3]

[3] Figures in brackets indicate literature references at end of this paper.

homogeneity [4].

In a previous publication [11], the preparation of a series of samples of fractionated cellulose acetate of widely different DP_w's was described. The present paper reports the results of studies of the effect of chain length and of heterogeneity with respect to chain length on a number of the mechanical properties of films prepared from these materials and their blends.

Experimental Procedure

The cellulose acetate fractions have been described in a previous publication [11]. They varied in DP_w, as determined viscometrically, from 30 to 380.

A. Preparation of films. Films 0.0025 to 0.0035 in. thick were prepared as follows: an acetate sample was shaken with a quantity of acetone, sufficient to give a solution with a viscosity of about 400 centipoises, until a homogeneous solution was obtained. The solution was poured onto a glass plate, and spread with a doctor blade which was held at a predetermined distance above the plate by means of runners. The plate was then placed in a carefully leveled rack. The above operations were performed in a cold room which was maintained at a temperature of approximately 10° C to decrease the rate of evaporation of the acetone. When the film was dry, it was wetted with water, removed from the plate, and then soaked in distilled water at 50° C for 3 hours to remove residual solvent. Films prepared by this method were uniform in thickness to approximately $\pm$ 0.0003 in.

B. Estimation of relative weight-average chain length. The DP_w's of the blends were estimated viscometrically in the same manner as was previously used for the fractions [11]. The specific viscosities of dilute solutions of the blends in Methyl Cellosolve (ethylene glycol monomethyl ether) were measured at 25° C and 60° C, and Staudinger's relationship [12] was used to calculate the DP's. The DP's reported later are the means of the values obtained at the two temperatures. Because of the limitations of the method of determining

them [13], the DP values should be considered as relative values.

c. Measurement of mechanical properties of films. All of the measurements of the mechanical properties of the films were made in an atmosphere having a relative humidity of 65 percent and a temperature of 21.1° C. Films approximately 0.003 in. thick were used for all of the tests. The actual thickness of each test sample was measured with a dial gage (graduated in ten-thousandths of an inch and with a foot pressure of 4 lb./in.^{2}).

The tensile strengths and ultimate elongations of the samples were measured on a "constant-rate-of-elongation" Schopper tensile tester equipped with a recording chart. Samples 0.25 in. wide were used. The distance between the jaws was 3 in., and the rate of separation of the heads was 12 in. per minute when the machine was running free. The minimum thickness of each strip was used in calculating the tensile strengths. At least 10 measurements were made on each fraction and blend. The probable error of the mean for a set of measurements was approximately 3 percent for the tensile strengths and 10 percent for the ultimate elongations.

The folding endurances of the samples were measured by means of an MIT fold tester [14], with a tension of 1.5 kg. Strips 1.50 cm wide were used. Since the

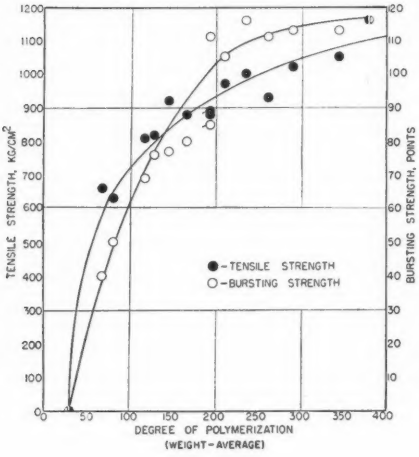

Fig. 1. Tensile and bursting strengths of cellulose acetate fractions as a function of the viscometrically-estimated DP. The starting material is designated by tagged circles.

folding endurance is fairly sensitive to the thickness of the test strip (thinner films having a higher folding endurance is this range of thickness), it was necessary to correct the results to a standard thickness (0.003 in.) of test strip. This was done by applying small empirical correction factors, which were determined by measuring the folding endurances of strips of the same material, but of different thicknesses. The correction factors were determined for several blends of fractions as well as for two commercial cellulose acetates, and were found to agree within 4 percent for a given thickness. About 15 strips were used for the measurement of the folding endurance of each fraction and blend. The probable error of the mean was approximately 8 percent.

Folding endurance measurements were made both in the direction in which the doctor blade was moved in spreading, and at right angles to this direction. No significant difference was found in the properties in these two directions. This result indicates that as far as the mechanical properties are concerned, the films do not have "machine" and "cross" directions.

The bursting strengths of the films prepared from the fractions were measured on a Mullen tester [15]. Ten bursts were made for each sample, and the results were corrected to a film thickness of 0.003 in.

Results

1. Mechanical properties of the fractions. The variation of the tensile and bursting strengths of the fractions with DP_w is shown in Fig. 1. As would be expected, there is a close correspondence between the two properties [15]. The general shape of the curve for the tensile strengths agrees well with the results obtained by other investigators [2, 3], although it is apparent that the strength is by no means independent of chain length in the range of DP's covered by these materials. The material of DP 30 would not form a coherent film, and was therefore assigned a strength of zero.

In addition to the above measures of strength, im-

pact strength measurements were made on thin, narrow strips of the fractions.[4] The shape of the curve obtained by plotting impact strength against DP_w was closely similar to that for the bursting and tensile strengths. It is of interest to note that for all three of the strength tests described above, the starting material (designated by tagged circles in Fig. 1) appears to be only slightly, if at all, inferior to a fraction of corresponding DP_w.

The ultimate elongations and folding endurances of the fractions are shown in Fig. 2. The results indicate a close relationship between these two quanti-

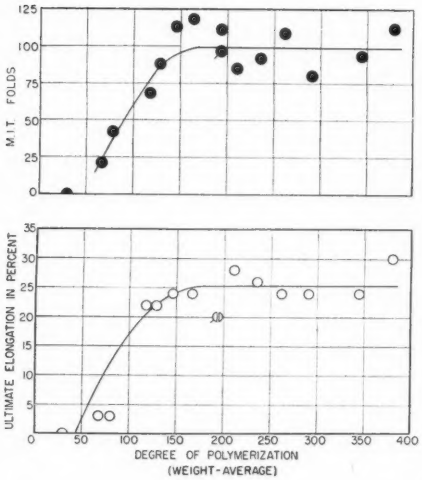

Fig. 2. Ultimate elongations and folding endurances of cellulose acetate fractions as a function of the viscometrically-estimated DP. The starting material is designated by tagged circles.

ties, and as will be shown later, a similar correspondence was found for the blends. Both of these mechanical properties appear to be independent of chain length above a DP_w of approximately 150. The original material does not appear to differ significantly from a fraction of corresponding DP_w.

The first fraction obtained in the fractional precipitation procedure was characterized by its haziness and high ash content. Because it was not completely soluble in acetone or Methyl Cellosolve, no estimate of

[4] We are indebted to F. D. Pilgrim and W. O. Kearse of the Tennessee Eastman Corporation for making the impact strength measurements.

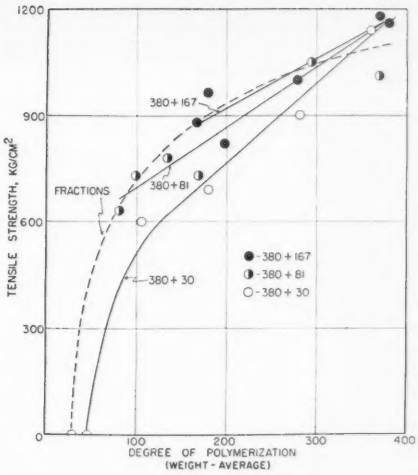

Fig. 3. Tensile strengths of blends of cellulose acetate fractions as a function of the viscometrically-estimated (weight-average) DP. The dotted line is the curve for the fractions, traced from Fig. 1. The tagged circle is common to all three series of blends.

its DP_w was obtained, and the data for its mechanical properties are therefore not included in Figs. 1 and 2. This material had a tensil strength of 1000 Kg/cm², a folding endurance of 86, and an ultimate elongation of 18 percent. These mechanical properties are similar to those of the fractions of high DP.

It should be noted that at low DP_w's the folding endurance is much more sensitive to variation in chain length than is the tensile strength. Thus the ratio of the highest folding endurance to the lowest (with the exception of the fraction that will not form a film) is about 5:1; the corresponding ratio for the tensile strengths is less than 2:1.

A number of other mechanical properties[5] of the fractions were measured in addition to those described above. They are referred to only briefly, since they show little variation with chain length. Films prepared from fractions of DP's 67 and 380 were found to have moduli of rigidity which did not differ significantly. The flexural resiliences, as measured with the Schiefer

[5] Measurements have been made of the flow characteristics (elongation as a function of time at constant load) of several of the fractions and the starting material. These results will be presented elsewhere, together with some results of load-elongation measurements on these materials [16].

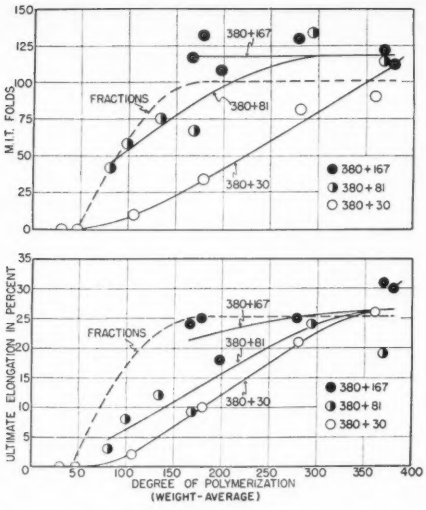

Fig. 4. Ultimate elongations and folding endurances of blends of cellulose acetate fractions as functions of the viscometrically-estimated DP. The dotted lines are the respective curves for the fractions, traced from Fig. 2. The tagged circles are common to all three series of blends.

Flexometer [17], of these two fractions and of the starting material were found to agree within the experimental error.

2. Mechanical properties of blends of the fractions. In order to study the effect of heterogeneity with respect to molecular chain length on the mechanical properties, a comparison of these properties for blends of different composition was made. The results are given in Table II and shown graphically in Figs. 3 to 7.

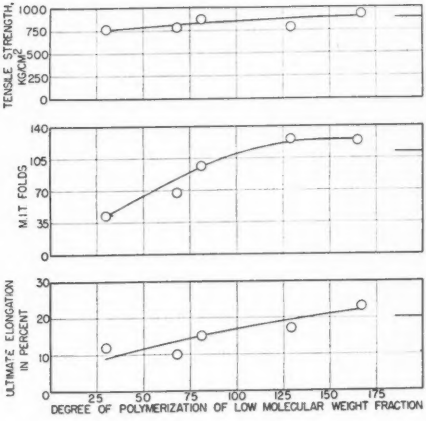
TENSILE STRENGTH, KGCM²
M.I.T. FOLDS
ULTIMATE ELONGATION IN PERCENT
DEGREE OF POLYMERIZATION OF LOW MOLECULAR WEIGHT FRACTION

Fig. 5. Mechanical properties of a series of blends, all of weight-average DP 200. The blends are composed of fractions of DP's 380 and X. The mechanical properties are plotted as functions of X, the viscometrically-estimated DP of the component of shorter chain-length. The mechanical properties of a fraction of DP 194 are represented by the bars at the right side of the graphs.

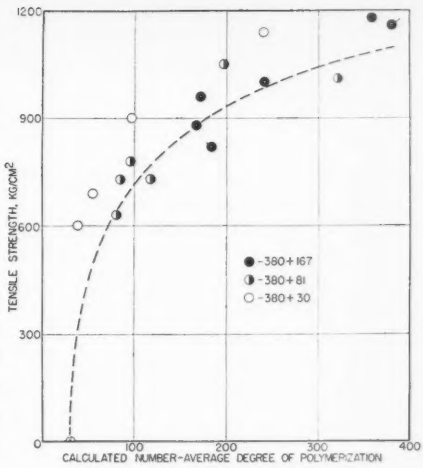

Fig. 6. Tensile strengths of blends of cellulose acetate fractions as a function of the calculated number-average DP. The dotted line is the curve for the fractions, traced from Fig. 1. The tagged circle is common to all three series of blends.

Fig. 3 shows the tensile strengths of the blends plotted against DP_w. The curves for the three series of blends (DP_w's 380 + 30, 380 + 81, and 380 + 167) have been represented by solid lines as a matter of convenience, although the data are such that these curves are somewhat ambiguous. The dotted line, which is traced from Fig. 1, is the curve for the fractions. The results appear to indicate a small but measurable harmful effect of the shorter chains on the tensil strength, since the results for the blends fall below the dotted line in general, especially for those blends which contain the fraction of DP_w 30.

A similar but much larger effect is shown by measurements of the folding endurance and ultimate elongation (Fig. 4). The curves for the series of blends 380 + 81 and 380 + 30 are markedly lower than the curves for the fractions (dotted lines traced from Fig. 2). The line for the folding endurances of the series 380 + 167 is, however, somewhat higher than the corresponding curve for the fractions. While there is a possibility that this may represent a slight superiority of these blends over the fractions, this does not appear too likely, since this effect is not shown by the results of the ultimate elongation measurements.

The effect of the shorter chains on the mechanical

properties of blends of different composition, but all of DP_w 200 is shown in Fig. 5. The values of the mechanical properties for the blends of the pairs 380 + 30, 380 + 81, and 380 + 167 were interpolated from the smooth curves of figures 3 and 4, and the other points represent the values for blends P and Q of Table II. The graphs clearly demonstrate that the effect of heterogeneity is greater on the folding endurance and ultimate elongation than it is on the tensile strength.

The data presented above indicate that at a given DP_w, the materials of shorter chain length exert a harmful effect on the mechanical properties of blends. It is of particular interest to plot the data on the basis of the DP_n's of the fractions and blends as well. This requires the estimation of the DP by other means (such as osmotic pressure measurements), but since such data were not available,[6] recourse was had to calculated values.[7] These are given in column 6 of Table II.

The mechanical properties of the blends are plotted against their calculated relative DP_n's in Figs. 6 and 7. The dotted lines are not drawn to fit the points, but are the curves for the respective mechanical properties of the fractions, traced from Figs. 1 and 2. As shown in Fig. 6, all of the tensile strength data for the blends,

[6] Measurements in progress.

[7] The values of DP_n for the blends can be calculated from the formula

$$DP_n = \frac{100}{\frac{f_1 r_1}{DPw_1} + \frac{f_2 r_2}{DPw_2}},$$

where DP_n is the number average DP of the blend, f_1 and f_2 are the weight percentages in the blend of the fractions of DPw_1 and DPw_2, respectively. $r_1 = DPw_1/DP_{n_1}$, and $r_2 = DPw_2/DP_{n_2}$. Since the fractionation process produces fractions that are relatively homogeneous, r_1 may be taken equal to r_2. The formula given above then reduces to the following:

$$DP_n = \frac{100}{r_1\left(\frac{f_1}{DPw_1} + \frac{f_2}{DPw_2}\right)}.$$

The figures given in column 6 of table 2 were calculated from this formula, with a value of unity assigned to r_1. They therefore represent relative calculated values.

regardless of composition, are reasonably well represented by the curve for the fractions, although the data for the series of blends 380 + 30 (open circles, Fig. 6) appear to be over-corrected by this method of calculation. Thus, in Fig. 6 the open circles fall above the dotted line in general, whereas in Fig. 3 (in which the tensile strengths are plotted against DP_w), they fall below it. A more critical test is provided by the folding endurance data, since the differences caused by the admixture of material of short chain length are apparently larger for this property. Fig. 7 shows that the folding endurance data for the blends are also reasonably well represented by the curve for the fractions (dotted line). The results for the ultimate elongations appear to parallel the results for the folding endurance measurements. Fig. 7 should be compared with Fig. 4, in which the folding endurances and ultimate elongations are plotted against DP_w.

It is of interest to note that the results for the blends P, Q, R, and S (which have not been included in the curves) would also fall close to the dotted lines of Figs. 6 and 7.

(Continued on page 30.)

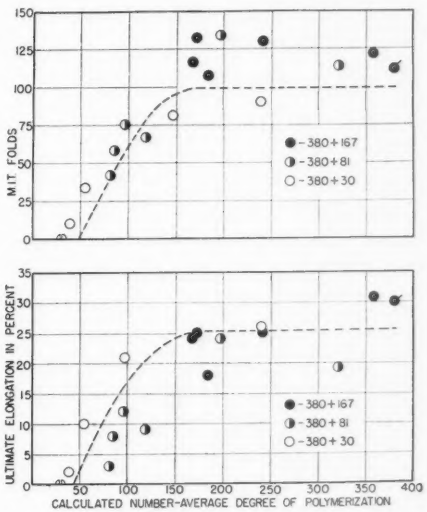

Fig. 7. Ultimate elongations and folding endurances of blends of cellulose acetate fractions as functions of the calculated number-average DP. The dotted lines are the respective curves for the fractions, traced from Fig. 2. The tagged circle is common to all three series of blends.

TABLE I. Homogeneity and mechanical properties of some high-polymeric materials

Material	Mechanical properties investigated	Conclusions	Investigator	Reference
Cellulose acetate films	Tensile strength	Blends superior to fractions of corresponding DP's	Rocha	[5]
Cellulose acetate filaments	do.	do.	Ohl	[6]
do.	do.	Materials of low DP exert a harmful effect, and those of intermediate DP a beneficial effect on the tensile strengths of blends of the same average DP.	Mark	[7]
Cellulose nitrate films	Load-elongation curve	In region of plastic flow of load-extension curve, blends require a higher load to produce a given elongation than do fractions of corresponding DP's	Medvedev	[8]
do.	Tensile strength, and ultimate elongation	Little difference between fractions and blends	Rogovin and Glazman	[10]
do.	Tensile strength, ultimate elongation and folding endurance	Folding endurances of blends inferior to those of fractions of corresponding DP's. Tensile strengths and ultimate elongations insensitive to changes in heterogeneity.	Spurlin	[4]
Viscose filaments	Numerous measures of strength and flexibility	Material of low DP's exerts a disproportionate harmful influence on the mechanical properties of blends	Schieber	[9]
Vinyl chloride-acetate copolymer plastic	Numerous measures of strength and flexibility	Blend inferior in fatigue resistance and approximately equal in strength to fraction of corresponding DP	Douglas and Stoops	[3]

TABLE II. Properties of blends of cellulose acetate fractions

Designation	Composition	Wt. percentage of lower DP	Weight-average DP (calc.)	Weight-average DP (obs.)	Number average DP (calc.)	Folding endurance	Tensile strength	Ultimate elongation
						Folds	*g/cm²	percent
1[a]	380+30	0	380	380	380	112	1160	30
A	do.	5	363	360	240	90	1140	26
B	do.	25	293	281	97	81	900	21
C	do.	51	200	180	55	34	690	10
D	do.	75	118	106	39	10	600	2
E	do.	95	48	47	31	0	0	0
15[a]	do.	100	30	30	30	0	0	0
F	380+81	5	365	369	321	114	1010	19
G	do.	25	305	294	197	134	1050	24
H	do.	60	200	169	118	67	730	9
I	do.	80	141	134	96	75	780	12
J	do.	95	96	99	85	58	730	8
13[a]	do.	100	81	81	81	42	630	3
K	380+167	5	369	370	358	122	1180	31
L	do.	45	284	279	241	130	1000	25
M	do.	84	200	198	184	108	820	18
N	do.	95	178	179	172	132	960	25
O	do.	100	167	167	167	117	880	24
P	380+68	58	200	183	104	67	780	10
Q	380+129	50	255	247	193	103	1020	25
R	do.	72	200	196	158	125	780	17
S	291+81	43	200	195	138	74	940	24

[a] The properties of the fractions of DP's 30, 81, 167, and 380 have been included for comparison. The fractions are numbered to correspond with their designations in a previous paper [11].

Discussion

The data described above indicate that when the mechanical properties of the blends are plotted against their DP_w's, a harmful influence of the materials of shorter chain length (approximately DP_w 80 or less) can be observed. The magnitude of this influence is a function of the amount and DP of the shorter chains in a blend. On the other hand, the addition of a material of intermediate chain length to one of high DP does not appear to produce any marked beneficial or harmful effect. It may thus be said that under the conditions of these experiments, the mechanical properties are monotonic, but not single-valued functions of DP_w. On the other hand, when the mechanical properties of the blends are plotted against their calculated DP_n's, all of the data are reasonably well described by a single curve for each property. Since this curve approximates the curve for the fractions, it appears that the mechanical properties of the cellulose acetate films may be described as monotonic, single-valued functions of DP_n. In the absence of actual determinations of DP_n, this must be regarded as only a tentative hypothesis. It is interesting to note, however, that this hypothesis is qualitatively consistent with the concept that a sample ruptures in the tensile or folding endurance tester when a sufficient number of chain ends exist close together in the test strip [18]. This follows, since the number of chain ends in a cross-sectional element of the sample is inversely proportional to DP_n. It should be further noted, however, that the range of DP's covered by these experiments is not very large. It is quite likely that the empirical generalization advanced above would not describe the results adequately if materials of very high and very low DP's were blended. The results suggest, however, that for many industrial products, and particularly where materials of high and low DP's are blended, considerable advantage would attach to the determination of DP_n, since this quantity appears to be more closely related to the mechanical properties than DP_w.

The results described above are consistent with those obtained by a number of other investigators [3, 4, 9].

Since the results of Spurlin [4] on the mechanical properties of nitrate films were obtained under experimental conditions rather similar to those described above, they are of especial interest here. Spurlin found that at corresponding DP_w's, films prepared from fractions were superior in folding endurance to those prepared from straight-run commercial nitrocellulose, and that the latter were in turn superior to blends of the straight-run material. The differences in properties were attributed to differences in homogeneity, and in particular it was concluded that a reasonably smooth distribution curve is desirable in order to obtain good folding endurance. While this is an entirely reasonable deduction for the materials that were being investigated, the results of the present investigation indicate that consideration of the DP_n's of the blends and fractions might have led to a somewhat different interpretation of the results. Unfortunately, since Spurlin's blends were not prepared from fractions, it is impossible to calculate even approximate relative values of the DP_n's for his samples. The data are, however, at least qualitatively consistent with the hypothesis that has been presented above.

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ABSTRACTS

Returns from the recent questionnaire issued by our publications and publicity committee indicated a definite reader preference for the inclusion in Textile Research of a technical abstract department.

Therefore, with this issue we are inaugurating an abstract service which we plan to expand as rapidly as possible into a broad coverage of current publications.

In this first series of abstracts we have not attempted the classified arrangement that will be necessary with further growth of the service. We are continuing the department of "research briefs," in which will be included some of the articles of particular interest to executives. Reference to these will be found at end of the abstract section.

Cellulose in Liquid SO_2

Reactions of cellulose in liquid sulfur dioxide. Philip C. Shere, Jr., and Lawrence C. Brooks. *Rayon Textile Monthly* 23, p. 657–8 (Nov. 1942).

Spruce sulfite pulp and viscose were dissolved in liquid SO_2 and efforts made to form a variety of cellulose esters and ethers. Under the exptl. conditions only cellulose acetate could be formed. No other esters nor any ethers could be prepared. Hydrolysis of cellulose by H_2SO_4 in liq. SO_2 was also studied. Methods of preparing reagents and all laboratory procedures are described.

Esterified Cellulose

0-Pentaacetyl-*d*-gluconates of polyhydric alcohols and cellulose. M. L. Wolfrom and P. W. Morgan. *J. Am. Chem. Soc.* 64, No. 9, p. 2026–8 (Sept. 1942).

Mercerized cotton linters were esterified with *d*-gluconyl chloride pentaacetate in the presence of triethylamine and nitrobenzene, forming a fibrous product containing 0.4 0-pentaacetyl-*d*-gluconyl group per anhydroglucose unit. A modified cellulose acetate (1.72 acetyl groups per anhydroglucose unit) in pyridine gave a mixed ester containing 0.7 0-pentaacetyl-*d*-gluconyl group per anhydroglucose unit and in chloroform and triethylamine, a mixed ester containing 0.3 0-pentaacetyl-*d*-gluconyl group per anhydroglucose unit was formed.

Adsorption by Cellulose

On the adsorption of water vapour by cellulose. J. D. Babbitt. *Can. J. of Research* 20, p. 143–72 (Sept. 1942).

An attempt is made to gather the available data on the adsorption of H_2O by cellulose and to draw from these data a unified picture of the phenomenon. Various theories explaining the adsorption isotherm are tested. The Langmuir isotherm is shown to fit a small portion of the

curve at low relative humidities, and the polymolecular theory of Brunauer, Emmett, and Teller is found to give agreement up to the point where capillary adsorption is assumed to become predominant. It is pointed out that the assumptions involved in the theory of Brunauer, Emmett, and Teller are such that an equally satisfactory agreement might be obtained by assuming that the adsorption was confined to a monomolecular layer in which, owing to repulsive forces between neighboring atoms, the adsorbing force varied with the number of atoms. Thus it is still doubtful whether the adsorption is monomolecular or polymolecular. The investigation shows that the adsorption on cotton is similar to that on wood, except for the fact that the internal surface area available for adsorption is less by a factor of 1.86. An analysis is made of the data available for calculation of the heats of adsorption, and the values obtained from the different sources are compared. It is found that when the heats of adsorption are plotted against the relative humidity there is no appreciable difference between the values obtained with cotton and with wood. A mean value for the heats of adsorption is obtained. The relation between heats of adsorption and the latent heat of condensation is developed, and it is shown that there is an excess of internal energy in the adsorbed state over that of the liquid state. Finally, an explanation is advanced to account for the experimental fact that there is a reduction in total volume when water vapour is adsorbed on cellulose. An attempt is also made to show (i) how the water molecule may be attached to the cellulose surface by hydrogen bonds in such a way that the energy will be greater than that in liquid water, and, (ii) that, on the basis of such a picture a volume contraction is to be expected.

Nitrogen Determination

Kjeldahl nitrogen determination. L. P. Pepkowitz and J. W. Shive. *Ind. Eng. Chem., Anal. Ed.* 14, p. 914–6 (Nov. 1942).

A rapid method for micro Kjeldahl digestions is described, using selenium oxychloride and perchloric acid. No loss of nitrogen occurs if the method is followed as described.

Nitroparaffins

The nitroparaffins and their derivatives. Their use in the chemical processing of textiles. Hillary Robinette. *Am. Dyestuff Rptr.* 31, p. 575–80 (Nov. 1942).

The nitroparaffins react with HCHO to form nitrohydroxy compounds useful as heat sensitizers for rubber latex, zein solvents, mild oxidizing agents, high boiling solvents and plasticizers, surface active agents, and flotation agents as well as softening and finishing agents for textiles. These compounds can be reduced to aminohydroxy compounds useful as emulsifying agents for mineral oils and waxes. Aminohydroxy compounds react with fatty acids to form soaps soluble in a wide variety of liquids and which are excellent scouring agents for textiles. These soaps are mildly alkaline and are powerful emulsifiers for most oils, fats, waxes and resins that are normally used in processing textiles. Other interesting derivatives are substituted oxazolines, useful as cation-active finishing agents, and amino dioxanes which are excellent wetting agents. The physical properties of some of the nitroparaffins and their derivatives are given in 4 tables.

Monothioglycol

Monothioglycol. H. S. Olcott. *Science* 96, p. 454 (Nov. 13, 1942).

Monothioglycol, CH_2OHCH_2SH (also designated thioglycol, monothioethylene glycol and beta- or 2-mercaptoethanol), is a useful non-nitrogenous sulfhydryl reagent for protein investigations. It is a colorless liquid (b.p. 69–70° (28 mm)), completely soluble in water and most most organic solvents. Monothioglycol can be added to buffer solutions without appreciable changing pH or ionic strength. It gives a deep red nitroprusside test. The disulfide oxidation product, in contrast to cystine, is soluble in water in all proportions. That monothioglycol is a reducing agent for the disulfide linkages in proteins is indicated by its effect in increasing the solubility of keratins, decreasing the viscosity of enzyme-free wheat gluten dispersions and activating papain. It should be found useful in providing a suitable environment for preventing the air oxidation of reduced proteins during dialysis without interfering with subsequent mobility determinations. Details of the experiments mentioned will be described in later publications.

Polymerization

Random reorganization of molecular weight distribution in linear condensation polymers. P. J. Flory. *J. Am. Chem. Soc.* 64, No. 9, p. 2205–12 (Sept. 1942).

The individual molecules of a linear polyester have only a temporary existence when heated to a suitable temperature, due to the occurrence of ester interchange between an ester group of one polymer molecule and the terminal functional group of another. While such processes have no effect on the number average degree of polymerization, they may modify the distribution of species. Such considerations lead to the concept of an entropy of heterogeneity and of an equilibrium size distribution; the latter is identical with that obtained directly by random polycondensation. The transformation in the distribution of species in a mixture of polyesters has been observed by viscosity measurements. The results confirm the theoretical predictions. The conversion of a cyclic ester (lactone) to a linear polyester should yield a much narrower distribution of species than is obtained by poly-condensation, but if ester interchange occurs between the polymer molecules subsequent to their initial formation, the distribution will be broadened.

Standard Buffer Solutions

Provisional pH values for certain standard buffer solutions. R. G. Bates, W. J. Hamer, G. G. Manov, and S. F. Acree. *J. Research, Nat'l Bur. Stds.* 29, p. 183–90 (Sept. 1942).

For use in the calibration of electrometric pH assemblies, 17 standard buffer solutions have been investigated, and pH values at 20°, 25°, and 30° C have been assigned to them. The pH values of these solutions range from 2.27 to 11.68 and are considered accurate to $\pm$ 0.02 pH unit. Hydrogen-silver-chloride cells without liquid junctions were used for establishing the precise pH values of the buffer mixtures. The assumptions made to determine the activity coefficients of the ions in the mixtures are discussed. The method of assigning an accurate pH value to a buffer mixture is outlined. Directions for preparing the mixtures from purified anhydrous salts, standard solutions of acid and alkali,

and pure water are given. Changes of temperature have a larger effect on the pH values of the buffers of pH greater than 7 than on those of the acid buffers. In all cases the effect of dilution is small; an error of 1 percent in the volume of solvent added results in a change of less than 0.001 pH unit. The use of a pH meter of the glass-electrode-calomel-electrode type calibated by means of a standard buffer may often involve greater uncertainties than those inherent in the pH value assigned to the buffer mixture. It should be recognized that errors arising from liquid junction, hysteresis, temperature, and salt effects may combine to give an uncertainty of 0.01 and 0.03 unit or more in practical pH tests.

Control of pH in Bleaching

Control of pH in bleaching. B. P. Ridge and A. H. Little. *J. Text. Inst.* 33, p. T33 (1942); *Ibid.*, p. T59. Reviewed in *Am. Dyestuff Rptr.* 31, p. 515 (Oct. 26, 1942).

Normally, in the bleaching and chlorination of textile fibers a fall in pH of the hypochlorite bath occurs with the result that reproducible conditions are difficult to obtain. A large fall in pH during acid bleaching (to pH 3 or below) would result in an evolution of chlorine gas with consequent loss of available chlorine, or a fall in pH of an alkaline liquor, such as used in bleaching of cellulosic fibers, to the neutral region could easily result in severe damage of the fibers by oxidation. A summary is given of conditions using buffers such that no appreciable change of pH occurs in the treatment of flax, jute, cotton, and rayon for various hypochlorite solutions of pH 11 to 4. Comments are made on the use of lime, soda ash, sodium sesquicarbonate, sodium pyrophosphate, sodium bicarbonate, and acetic acid. A summary of the behavior of the buffered bleaching liquors (quantity of buffer, pH, available Cl at start and after 60 minutes) are given for 12 linen, 10 jute, 4 cotton and 2 rayon treatments.

Copolymers of Vinyl Chloride and Acetate

Structure of copolymers of vinyl chloride and acetate. C. S. Marvel, G. D. Jones and G. L. Schertz. *J. Am. Chem. Soc.* 64, p. 2356–62 (Oct. 1942).

Vinyl chloride and vinyl acetate copolymerize to produce polymer chains containing both units. However, the polymer molecules produced in a given case differ widely in composition and the first chains produced are richer in vinyl chloride than is the monomer mixture from which they are formed. The copolymers made by complete polymerization of a given starting mixture of monomer vary in composition from chain to chain. The monomer units appear to be oriented in a 1, 3-fashion in the polymer chain. Some reactions of these copolymers have been described.

Viscosity of Viscose

Change in the viscosity of viscose by addition of reagents. P. C. Scherer and J. R. Leonards. *Rayon Textile Monthly* 23, p. 607–09 (Oct. 1942).

The effect on the viscosity of viscose syrup of replacing part of the water by various reagents was studied. In all cases except one, an increase in viscosity and a decrease in the gelling time were noted. The addn. of pyridine in quantities up to 8% by wt. of the soln. resulted in a decrease in the viscosity of from 20 to 30%, and an

increase in the gelling time of almost 100%. A possible mechanism for this effect is suggested.

Naphthol AS

Studies in the Naphthol AS series. Part V. Synthetic experiments II. R. V. Bhat and K. Venkataraman. *J. Soc. Dyers and Colourists* 58, p. 155–61 (Aug. 1942).

Continuation of a study of the effect of structural features of dyes of the Naphthol AS series on their dyeing properties (cf. *J. Soc. Dyers and Colourists* 56, 166–78 (1940)). Experimental details are given for the synthesis of 11 naphthols by condensing 2-hydroxy-3-naphthoyl chloride with various organic bases. The properties of these are listed including their colors on cotton, the effects of formaldehyde on their solutions, and the stability of the solutions on standing for 24 hours and 1 week. Dyeings of each were developed with Fast Red Salt TR and with Fast Blue Salt 2B and the colors, fastness to kier-boiling, light and rubbing, and the substantivity are recorded in a series of tables and graphs. Questions of constitution, substantivity and fastness are discussed. Results indicate that fastness to kier-boiling is improved if naphthols contain a sulfonamido-group meta to the naphthoyl amido-group rather than para. Naphthols containing thiazole rings or benzamido groups also exhibit enhaneed fastness. Naphthols containing free amino groups exhibit poor fastness, while the relative positions of the naphthoylamido and benzamido groups are of little consequence. In general, the rubbing fastness of all samples was very good. In fastness to light the p-phenylenediamine derivative was superior to the meta derivative, whereas the benzamido group is more useful in the p-position to the naphthoylamido-group than in the m-position. Other cases are discussed that indicate caution is necessary in generalizing with regard to the dependence of the fastness properties of azoic dyes on their constitution. Further evidence is given of the beneficient effect on substantivity of the thiazole ring and benzamido groups while carbonyl groups are shown to be ineffective. A naphthol combining the structural features of Naphthol AS–BO and AS–SW did not exhibit the high substantivity of either of these dyes.

Dyeing Cotton with Mineral Khaki

The dyeing of cotton with mineral khaki. IV. A comparison of the penetration, rubbing, fastness and handle of cotton dyed with pigments produced by chromate and alkali development methods. E. Race, F. M. Rowe, and J. B. Speakman. *J. Soc. Dyers and Colourists* 58, p. 161–2 (Aug. 1942); cf. *Ibid.*, 57, p. 257 (Aug. 1941).

The penetration, rubbing fastness and handle of cotton materials dyed with mineral khaki by the chromate, sodium hydroxide-sodium carbonate, and ammonia development methods have been compared. Uniformity of deposition of pigment is excellent by all three methods, none of which appears to have any advantage over the others in this respect. Although the rubbing fastness of the mineral khaki produced by each process is very poor, the chromate developed pigment is decidedly inferior in this respect to both sodium hydroxide-sodium carbonate and ammonia developed pigments, the latter being the best. In addition, the abrasive action of the chromate developed pig-

ment is severe compared with that of the ammonia developed pigment, which is slight, the sodium hydroxide-sodium carbonate developed pigment being intermediate in abrasive action. In all cases the fabric showed a noticeable increase in stiffness after pigmentation, the greatest effect being given by the ammonia developed pigment. Little difference in stiffness could be detected between materials containing the chromate and sodium hydroxide-sodium carbonate developed pigments, and in these cases the increased stiffness was much smaller than that given by the ammonia developed pigment.

Dispersed Dyes for Rayon

The dyeing of cellulose acetate rayon with dispersed dyes. T. Vickerstaff and E. Water. *J. Soc. Dyers and Colourists* 58, p. 116–25 (June, 1942).

Sorption isotherms for the dyeing of cellulose acetate have been determined and are shown to be curves of hyperbolic type. This indicates that dyeing does not consist in the formation of a true solution of dye in the fibre up to saturation as is the case in the partition of a dispersed dye between amyl acetate and water. Neither is the process one of adsorption, for the quantity taken up by the fibre is independent of the liquor ratio and is, therefore, a function of the weight of dye in the dyebath and not of the concentration of dye. In partition between amyl acetate and water an interfacial layer of dye particles is formed and desorption experiments indicate the presence of a similar layer on dyed cellulose acetate, but the quantity of dye in this layer is not sufficient to account for the shape of the isotherms. Microscopic observations show that no visible surface layer of dye particles is formed during the process of dyeing, nor is there any evidence of an appreciable attraction between fibre and dye particles at microscopic distances. Dyeing appears to take place by means of sub-microscopic particles, a conclusion which is supported by the fact that dyeing can take place when the dispersion of dye is enclosed in a cellophane bag. Re-dispersion experiments also indicate that large particles dye extremely slowly, if at all, and that the rate of dyeing increases with increasing dispersion. It is shown that the dyeing process is reversible.

The observed facts are best explained on the assumption that a colloidal solution of dye is formed in cellulose acetate.

Closely related homologues of the aminoanthraquinone series show widely differing affinities for cellulose acetate which is paralleled by their solubility in acetone. Binary mixtures of dyes may dye additively with corresponding improved building-up properties, or may interfere with one another, leading to poorer building-up. 29 references.

Evaluating Starches

Evaluating starches for textile purposes. W. T. Schreiber and W. L. Stafford. *Ind. and Eng. Chem. Anal. Ed.* 14, No. 3, p. 227–31 (March 1942).

Methods are described for evaluating starches for use on fabrics; these include methods for judging the starch mixtures from a processing or plant operating viewpoint and methods for evaluating the quality of starched fabrics. The former may be used for measuring the stickiness of starch mixtures during ironing, and the penetration of such mixtures; the latter may be used to measure the transparency of starch films, and to

determine the smoothness, stiffness, and resistance to crushing of starched fabrics. These methods may also be used to advantage in evaluating other sizing or finishing agents.

Determination of Water in Starch

Determination of water in starch and its modifications. L. Sair and W. R. Fetzer. *Ind. Eng. Chem., Anal. Ed.* 14, p. 843–5 (Nov. 1942).

Either the toluene distillation procedure or the vacuum-oven method at 100° gives reliable results for the moisture content of starch products. In the vacuum-oven method, air replacing the vacuum must be thoroughly dried and the oven must retain its vacuum for several hours after the pump is stopped in order that reliable results be obtained. Raising the oven temperature to 135° for rapid drying causes a loss of volatile material from highly acid modified starches and from hypochlorite-oxidized products. Starch dried over concentrated H_2SO_4 retains 1.00 to 1.65% of its moisture.

Cystine Reactivity

The reactivity of the cystine linkage in keratin fibers. Part I. The action of alkalis. J. L. Stoves. *Trans. Faraday Soc.* 38, No. 253, p. 254–61 (June–July, 1942).

The tensile strength of human hair is first decreased, then increased nearly to normal, and later decreased again by treatment with M/5 Na_2CO_3. Time required for each phase, as well as the extent of change is influenced by concentration, temperature and pH of the solution. The author believes the preliminary decrease in tensile strength is due to hydrolysis of disulfide bonds while formation of new bonds of the type —N=CH— and —C—S—C— between the peptide chains accounts for later strengthening of the fibers. The probable course of reaction is indicated.

Part II. The action of reducing agents. J. L. Stoves. *Ibid.* 261–7.

Hair treated with M/10 $Na_2S_2O_3$ shows maximum reduction in tensile strength at pH 4.5 and pH 11 but is practically unaffected by treatment at pH 7.5–9.5. Loss in tensile strength of bisulfite treated fibers can be almost completely restored by after-treatment with solutions of benzoquinone, HCHO, and $K_2Cr_2O_7$.

Cholesterol

Cholesterol in the rayon industry. Lester I. Conrad. *Rayon Textile Monthly* 23, p. 675–6 (1942).

Cholesterol, a polycyclic, secondary alcohol, is found in all normal tissues of man and higher animals, where it functions as a conveyor in the absorption of fats. In general it has been found to exert an unusual and noticeable effect in all processes where surface activity, interfacial tension and emulsification play a part. A blend of specially treated cholesterol and sterols is being used in the rayon industry as an emulsifier, stabilizer, and as a dispersing, penetrating, and finishing agent. The cholesterol remaining on the fibers imparts luster and results in very even, soft, strong yarns. Reviews of cholesterol research are listed.

Protein Chemistry

Industrial protein chemistry 1941–42. Johan Bjorksten. *Chem. Ind.* 51, p. 366–70 (Sept. 1942).

A review of 167 recent patents.

Effect of Ageing on Rayon

Effect of ageing on rayon yarn. Clarence B. Weil. *Textile World* 92, No. 11, p. 74–5 (Nov. 1942).

Rayon yarn was treated for 15 mins. at room temp. with an emulsion consisting of 10% sulfonated castor oil, 5% coconut oil, 3% French sheet gelatin and 4.2 times as much water as rayon. The samples were then stored for 33 days at 65% relative humidity along with untreated samples, some samples of each being stored in darkness. At intervals the breaking strength and stretch of the yarns were measured. The results indicate that the treatment had no effect on the strength or extensibility of rayon nor did it induce any photochemical decomposition.

Cloth Wearing Tester

A new design of cloth wearing tester. J. G. Martindale. *The J. Textile Inst.* 33, No. 9, p. T151–8 (Sept. 1942).

Details are given of an apparatus for measuring the comparative wear resistance of fabrics. Four circular areas of cloth 1½ in. in diam. can be tested simultaneously. They are mounted in special holders, the weight of the holder, about ½ lb., furnishing the force between the sample and the material against which it is rubbed. This material may be a portion of the cloth being tested or it may be different cloth, leather, or other material. Mechanisms are provided for imparting to each sample holder a movement which is the resultant of two simple harmonic motions at right angles to each other and of different period, the path traced by the sample relative to the stationary abradant being a series of ellipses known as a Lissojous figure. The samples are examined at stated intervals and the degree of wear is determined by visual inspection. The change in thickness and weight of the sample with the time of rubbing is suggested as an alternative method for evaluating the degree of wear. Results showing the changes in weight of several samples with the time of rubbing are given.

Wear Tests on Carpets

Wear testing of carpets. Herbert F. Schiefer, *J. Research of the Nat'l Bur. Stds.* 29, p. 333–79 (Nov. 1942).

The NBS and Shawmut machines for testing the wear resistance of carpets, a gage for measuring the thickness of carpets, and an instrument for measuring the length of a tuft of pile from a carpet are described. The effects of the height of the vacuum-cleaner nozzle above the pile, the amount of suction at the nozzle, and the relative humidity and temperature of the air in which the test is made, on the results obtained with the NBS machine were studied. The effect of systematic changes in carpet construction on the wear resistance was investigated with each machine and under severe service conditions. Tests on 24 carpets of Axminster, velvet, and Wilton weaves were made on the two types of machines in several laboratories, and the results obtained in the different laboratories were correlated with each other and also with the results of 3 years of service tests on the same carpets. The correlations were highly significant, but large systematic differences between the weaves and between the laboratories were obtained. The latter difference is attributed primarily to a lack of uniformity in the testing procedures. Three types of vacuum-cleaning systems were used during the service

tests, and their effect on the wear of the carpets and the effectiveness of cleaning were observed. The *S* index, which is the time required to wear the pile of a carpet down to one-fourth of the matted pile thickness, corresponds closely with the time at which a carpet in a service test would be discarded on account of visible wear. The deviation of the *S* index of a single test from the average is less than 10% in 9 trials out of 10. The nature of the wear produced by the two machines on the pile fibers was found to be similar to that produced during the service tests. The analyses of carpets do not yield sufficient data to determine the probable durability of carpets in general. The relative wear of carpets for a given use can be evaluated by means of laboratory wear tests. For general interlaboratory comparison of the relative wear resistance of carpets, the testing machines and the testing procedures must be rigidly standardized and controlled.

Fatigue of Fabrics

Fatigue of fabrics. W. F. Busse, E. T. Lessig, D. L. Loughborough, and L. Larrick. *J. Applied Physics.* Vol. 13, No. 11, p. 715–24 (Nov. 1942).

The effect of temperature and time of application of load on the growth and the apparent "tensile strength" of fabrics was studied with a number of new tests. The results gave considerable information about the mechanism of failure of mechanical fabrics at low loads in service which could not be obtained with standard textile tests. A "fatigue" test was developed which measured the lives of samples at elevated temperatures when subjected to a constant average load and a superimposed cyclic stress. The change in life with temperature on this test is enormously greater than the change of tensile strength with temperature. Over a considerable range the logarithm of the life under a given load is a linear function of the reciprocal of the absolute temperature, showing that the failure depends on a viscous or plastic flow within the fibers. Calculated activation energies for this flow process increase for different fibers in the order rayon, cotton, Nylon. The construction of the fabric affects the absolute life, but not the calculated activation energy. When creep is negligible, a loaded cord contracts when the temperature is raised, analogous to the Joule effect in rubber.

Flexural Fatigue of Textiles

Flexural fatigue of textiles. H. F. Schiefer and P. M. Boyland. *J. Research Nat'l Bur. of Stds.* 29, p. 69–71 (July, 1942). *Textile Research,* 12, No. 11, p. 2 (Sept. 1942).

Results are given which indicate that the ability of a textile fabric to withstand repeated flexing depends upon the structure of the fabric, the position and structure of the yarn in the fabric, and the kind of fiber from which the fabric is made. Photomicrographs are given showing that in a plain weave, failure of fibers caused by flexual fatigue occurs in alternate yarns. Schematic drawings are included to illustrate an explanation of this phenomenon.

Rayon Blends. (See page 13.)
Cotton Hosiery Portfolio of Design. (See page 13).
Measurement of Speeds with Stroboscopic Light. (See page 14.)
Milkweed Fiber. (See page 14.)